

# LANDSAT SATELLITE OBSERVATIONS AND CROWD-SOURCED DATA PROVIDE NEAR REAL- TIME MONITORING OF CHIMPANZEE HABITAT

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the Jane Goodall Institute





# Partners





# Introduction

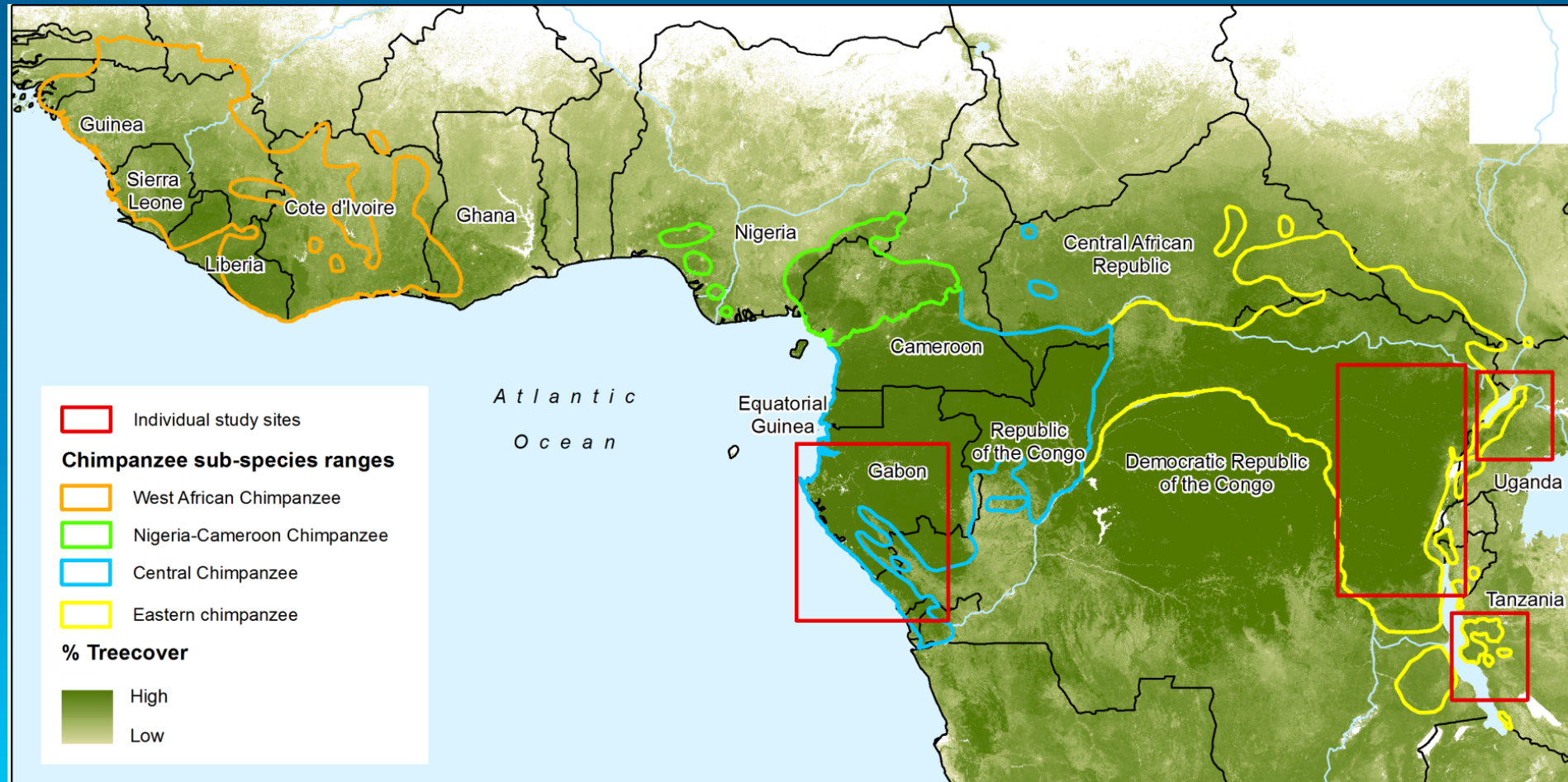
- Habitat loss and degradation is one of the major threats to chimpanzees
- Relatively few studies exist on mapping chimpanzee habitat suitability and have been at the local scale, coarse in resolution or both.
- Only two studies have attempted to address habitat change through time (Torres et al. 2010 & Junker et al. 2012).
- Could we use a combination of species modeling, 30-meter Landsat satellite imagery, and crowd-sourced field data to systematically monitor habitats at scales locally relevant and consistent across the entire chimpanzee range in Africa?





# Objective & Geographic Scope

- Develop a **practical** and **operational** Decision Support System (DSS) to annually monitor and forecast chimpanzee habitat health in Africa
- Focus on dynamic habitat variables directly derived from updatable satellite imagery
- Emphasis on the bottom up evaluation approach and decision making to assess feasibility of DSS





# Open Standards as a Conservation Decision Making Framework

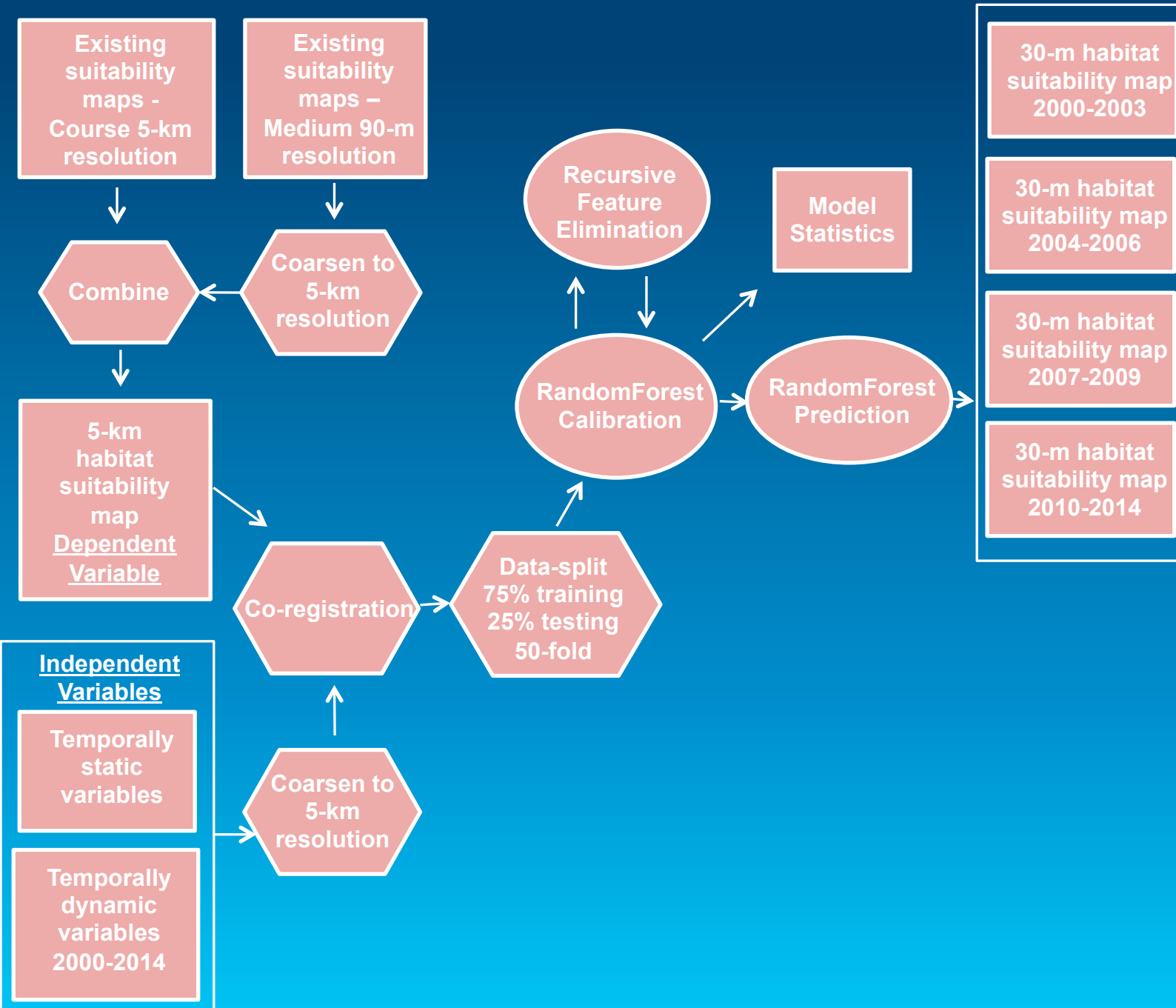




# Crowdsourcing data (community monitoring, research surveys, UAVs)







# DSS Workflow

## Decision Makers







Article

# Landsat ETM+ and SRTM Data Provide Near Real-Time Monitoring of Chimpanzee (*Pan troglodytes*) Habitats in Africa

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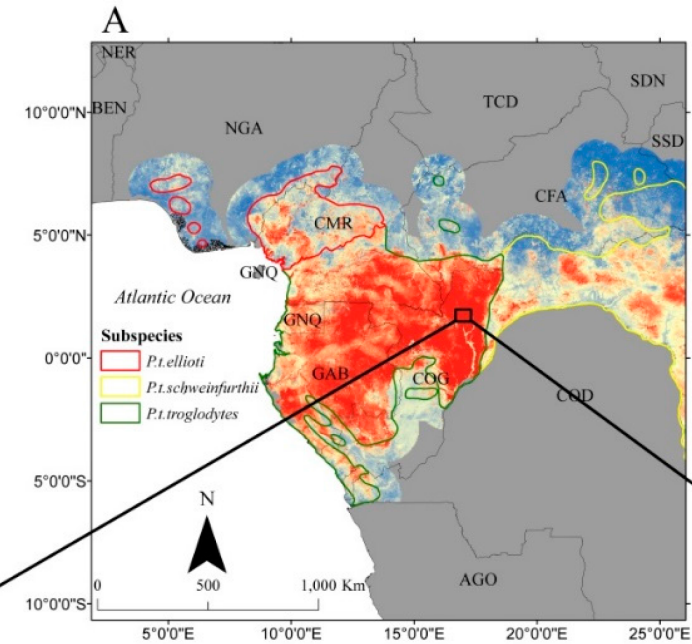
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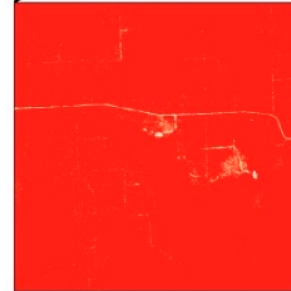
\* Correspondence: sjantz@umd.edu; Tel.: +1-301-405-2140; Fax: +1-301-405-6806

Academic Editors: Susan L. Ustin, Zhaoliang Li and Prasad S. Thenkabail

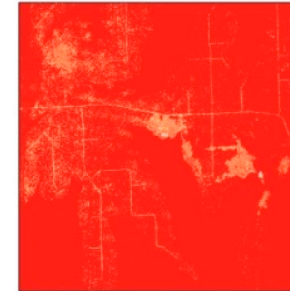
Received: 2 February 2016; Accepted: 12 May 2016; Published: 20 May 2016



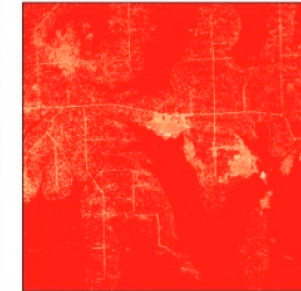
B - 2003



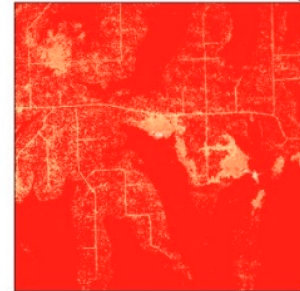
C - 2006



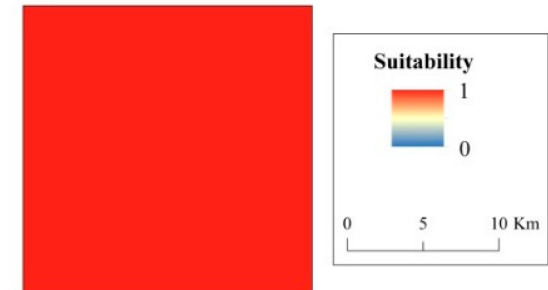
D - 2009



E - 2012



F



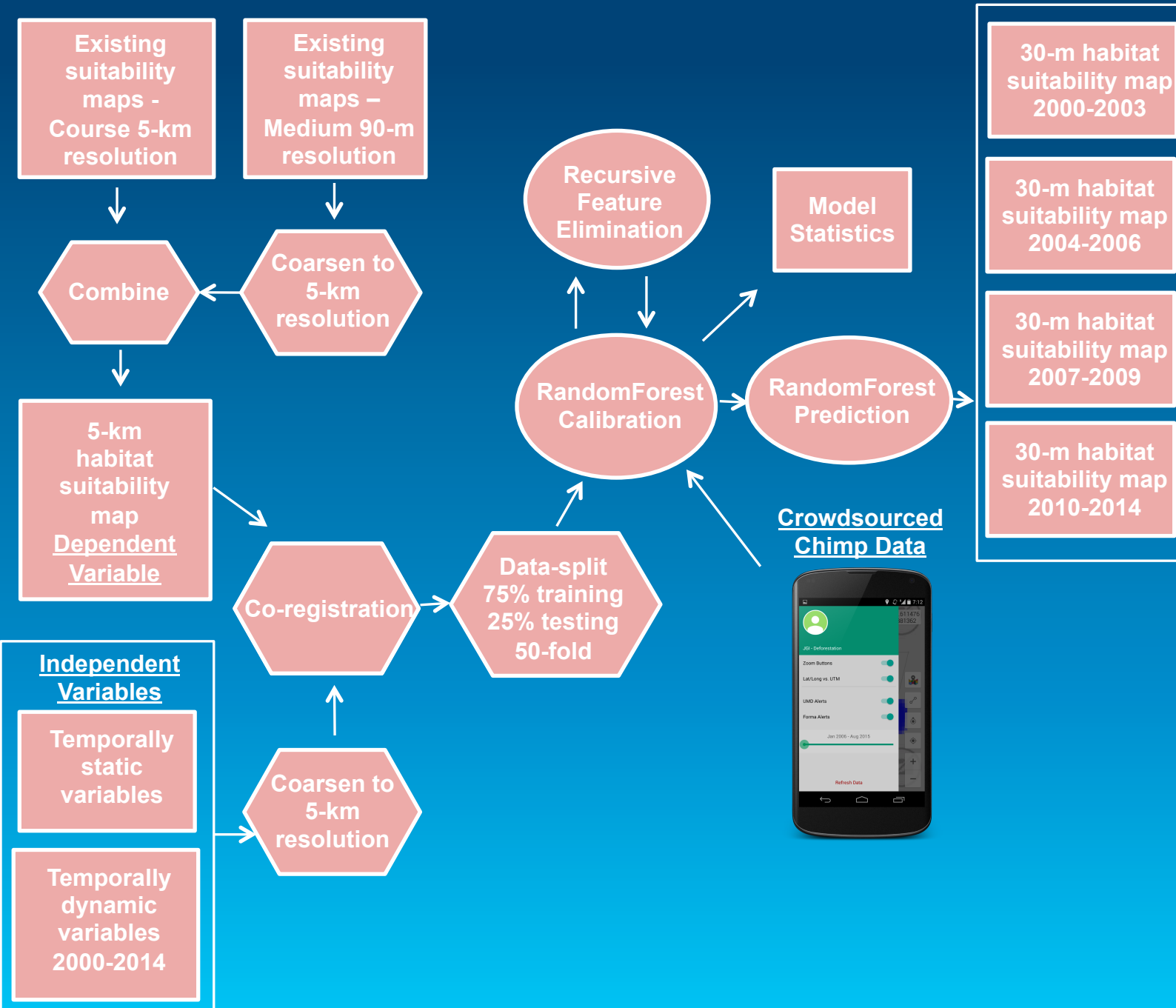


# List of predictor variables used as input to Random Forest regression models.

\* indicates variable was included in final model.

Variable	Units	Source	Abbreviation
Landsat ETM+ band 3 (0.63 – 0.69 $\mu\text{M}$ )	% reflectance	Hansen et al. 2013	B3
Landsat ETM+ band 4 (0.77 – 0.90 $\mu\text{M}$ )	% reflectance	Hansen et al. 2013	B4
Landsat ETM+ band 5 (1.55 – 1.75 $\mu\text{M}$ )	% reflectance	Hansen et al. 2013	B5*
Landsat ETM+ band 7 (2.09 – 2.35 $\mu\text{M}$ )	% reflectance	Hansen et al. 2013	B7
Normalized band4/band3	Unitless	Hansen et al. 2013	NormB4/B3
Normalized band4/band5	Unitless	Hansen et al. 2013	NormB4/B5
Normalized band4/band7	Unitless	Hansen et al. 2013	NormB4/B7*
band3/band5	Unitless	Hansen et al. 2013	B3/B5*
band3/band7	Unitless	Hansen et al. 2013	B3/B7
band5/band7	Unitless	Hansen et al. 2013	B5/B7
Canopy cover	Percent	Hansen et al. 2013	CC*
Canopy height	Meters	Hansen et al. 2013	HT*
Distance to forest	Meters	Hansen et al. 2013	DF
Distance to forest loss	Meters	Hansen et al. 2013	DL
Forest loss in 1-km buffer	Proportion	Hansen et al. 2013	L1K
Forest loss in 25-km buffer	Proportion	Hansen et al. 2013	L25K*
Distance to forest edge	Meters	Hansen et al. 2013	DE*
Forest edge in 1-km buffer	Proportion	Hansen et al. 2013	E1K
Forest edge in 25-km buffer	Proportion	Hansen et al. 2013	E25K*
Distance to rivers	Meters	SWBD	DR*
Distance to steep slopes	Meters	SRTM	DS*
Elevation	Meters	SRTM	EL*
Slope	Degrees	SRTM	SLP*



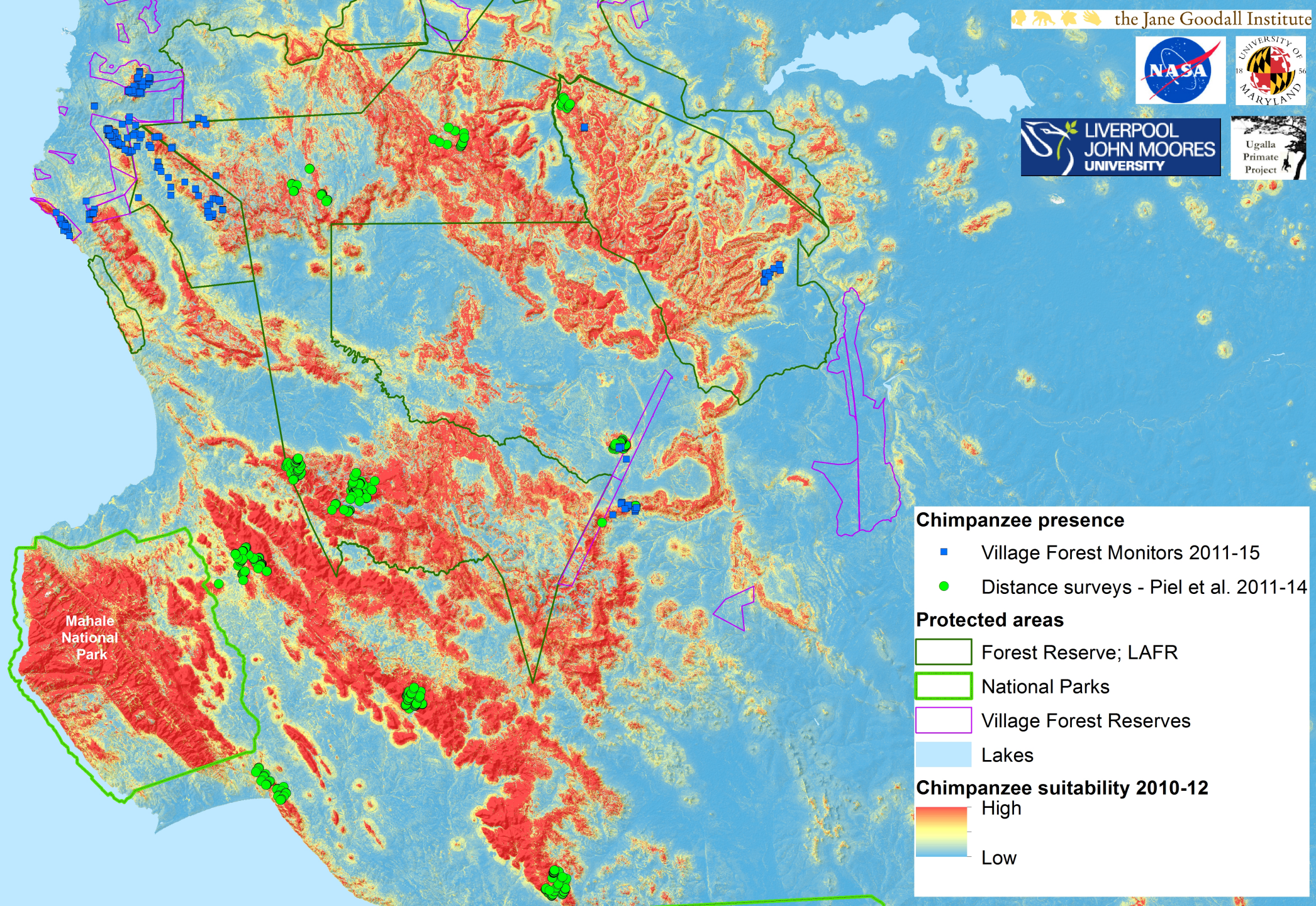


# DSS Workflow

## Decision Makers







### Chimpanzee presence

- Village Forest Monitors 2011-15
- Distance surveys - Piel et al. 2011-14

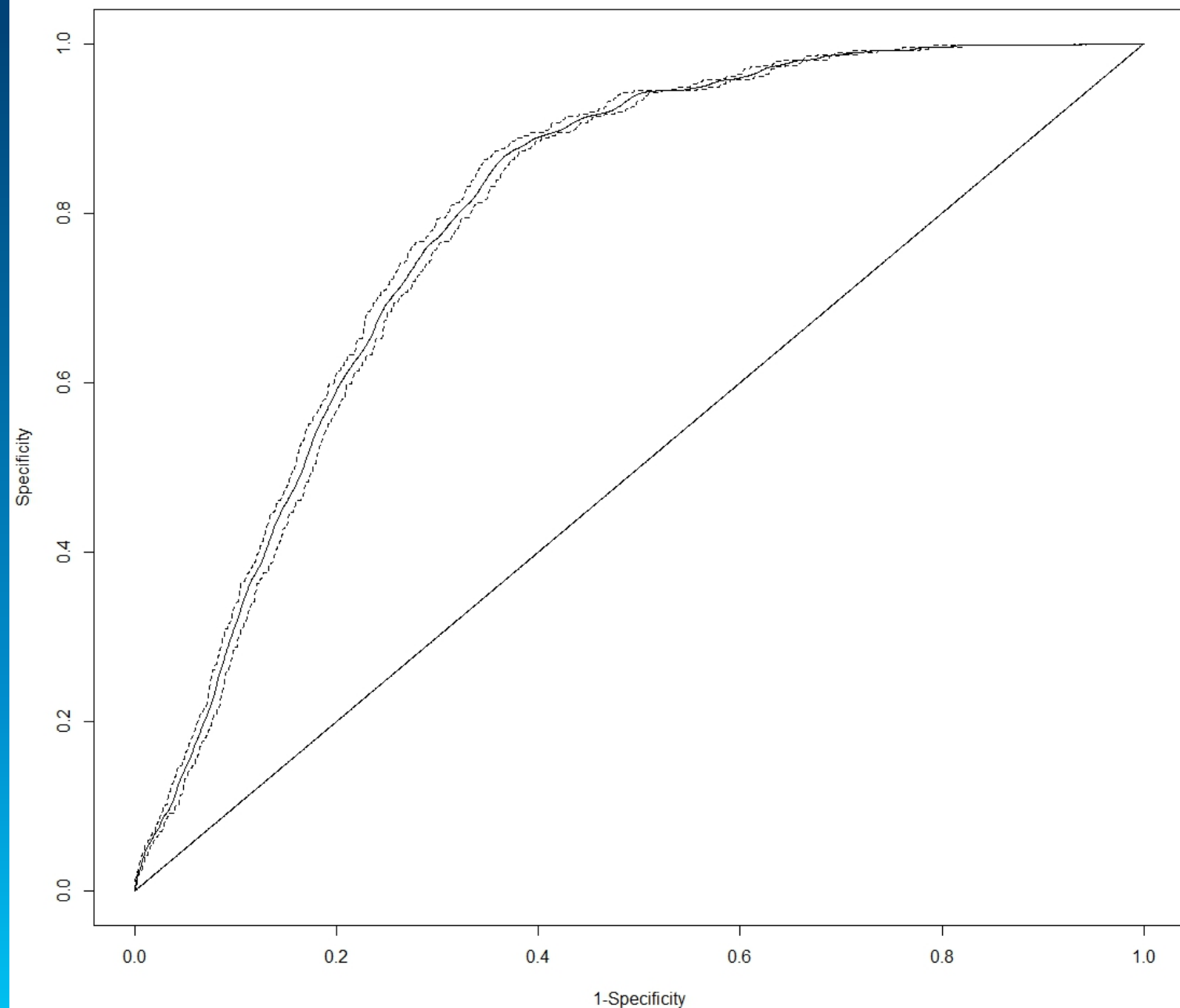
### Protected areas

- Forest Reserve; LAFR
- National Parks
- Village Forest Reserves
- Lakes

### Chimpanzee suitability 2010-12

- High
- Low





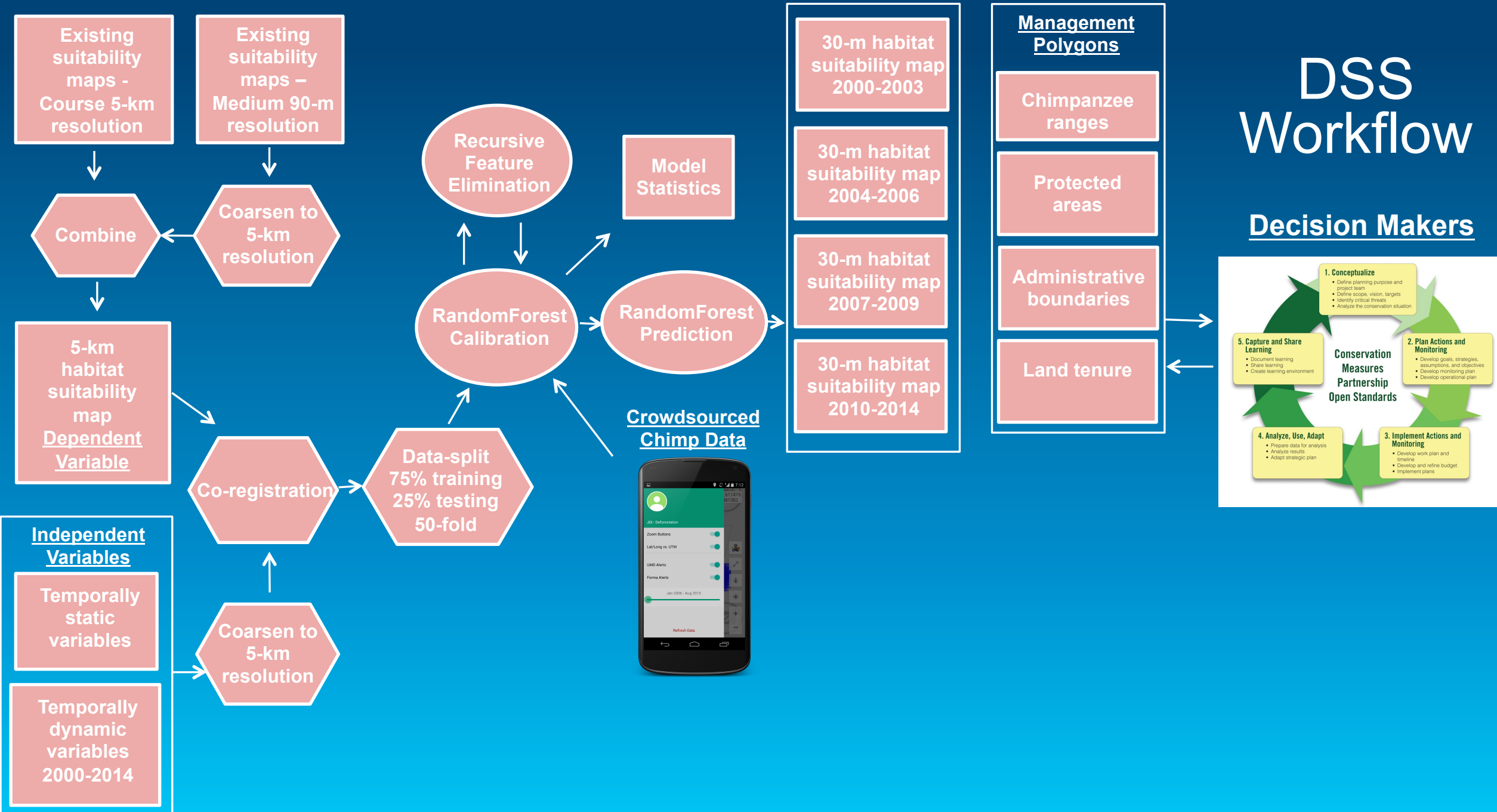
## Model performance - Tanzania

Good - the mean AUC (area under the curve) = 0.79

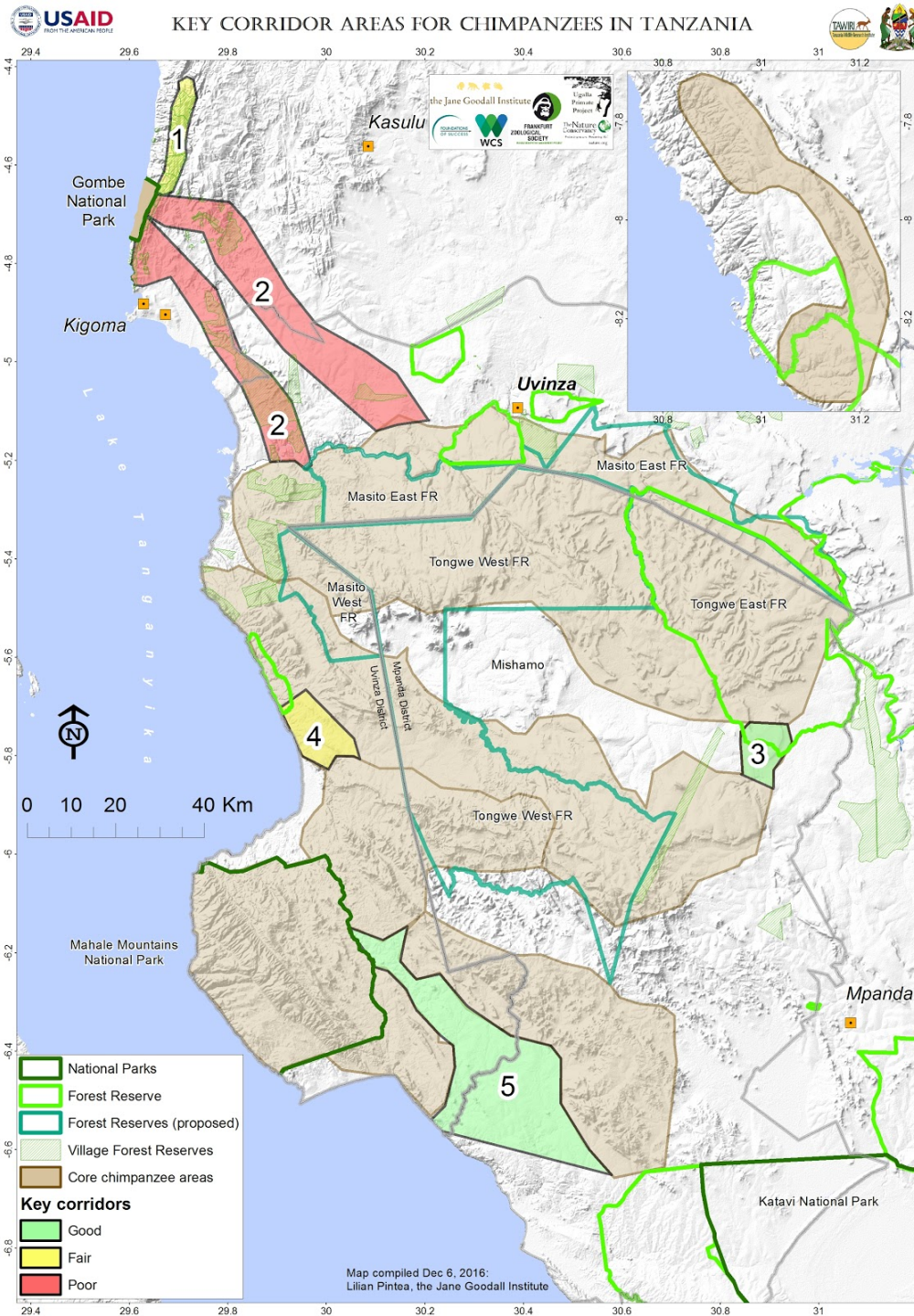
The receiver operating characteristic (ROC) curve with mean, min and max values based on 100 boot-strapped samples of 468 unique nest locations from 2011-14 Distance Surveys (Piel et al.) and 10000 background samples for each trial.

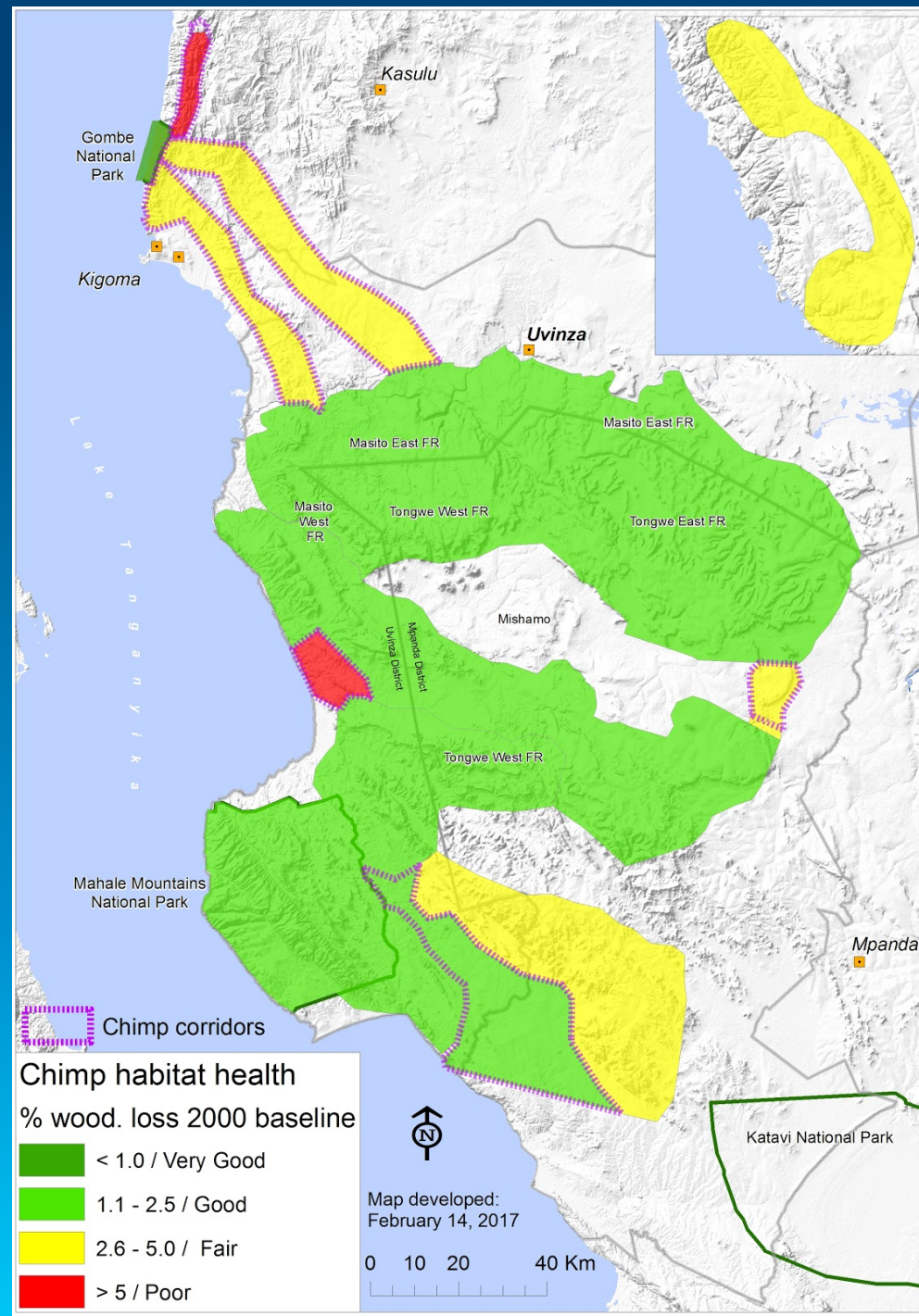
Baldwin R. Use of maximum entropy modeling in wildlife research. *Entropy*. 2009;11(4):854–66.



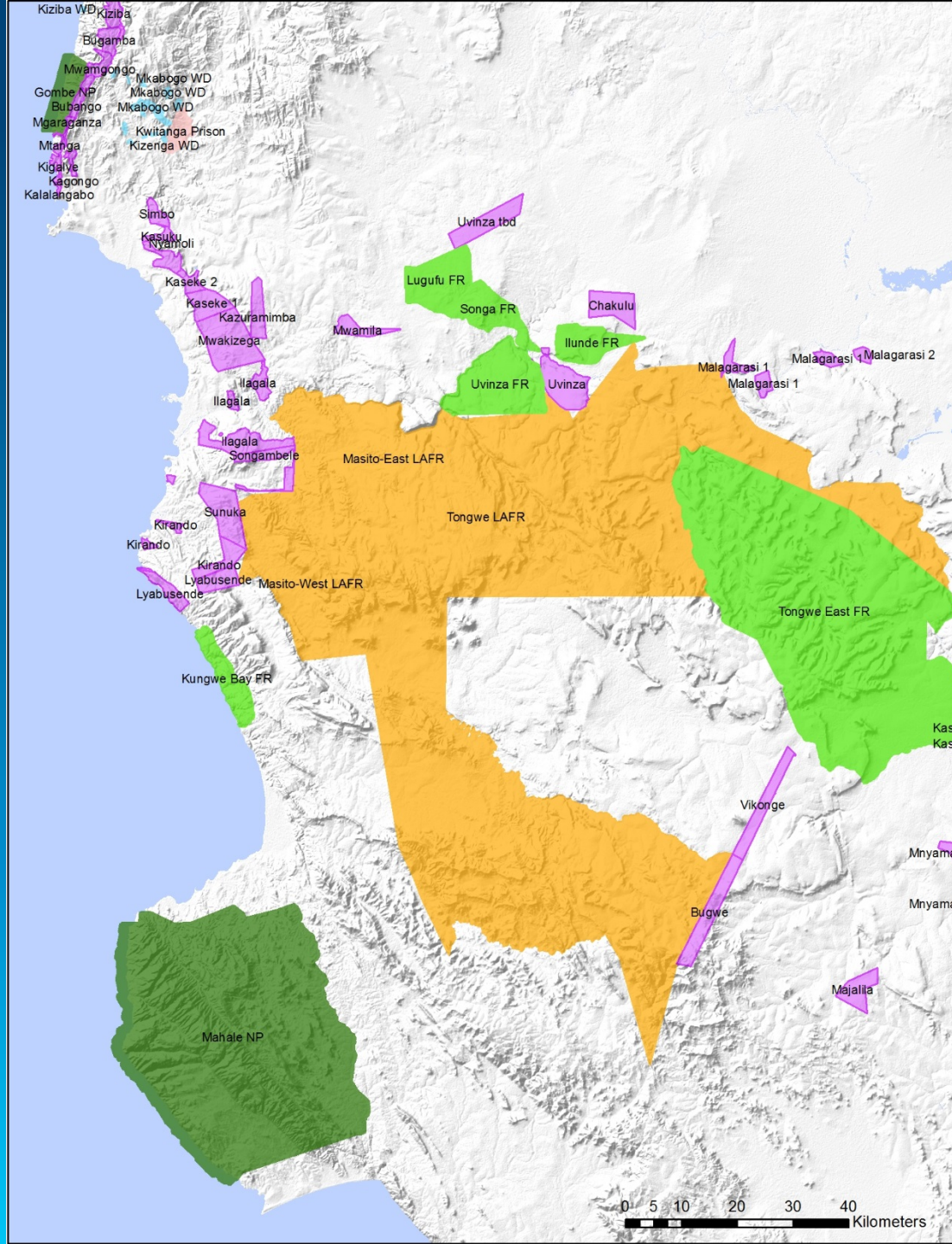












# Chimp habitat health 2014

% of 2000 baseline forest loss

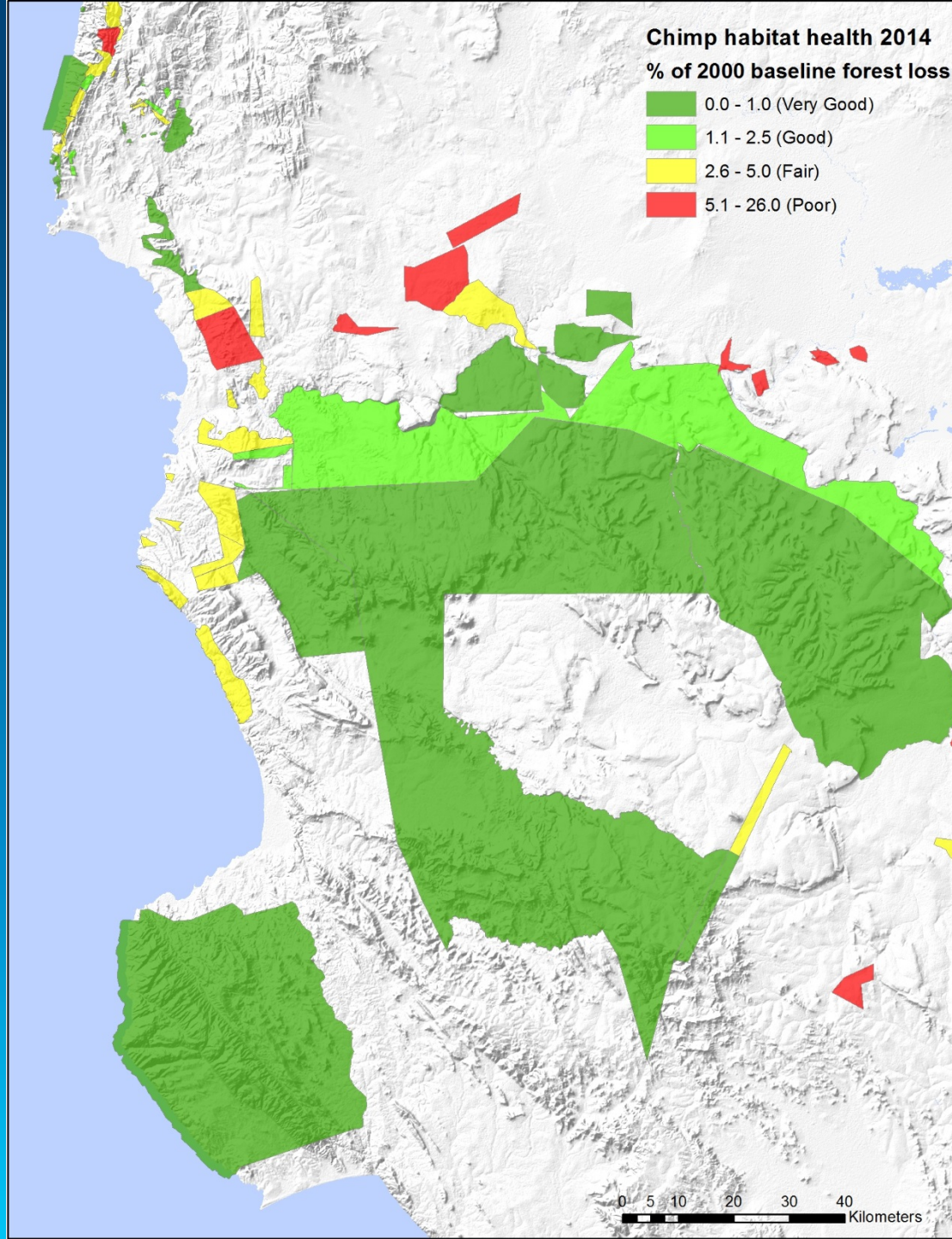
0.0 - 1.0 (Very Good)

1.1 - 2.5 (Good)

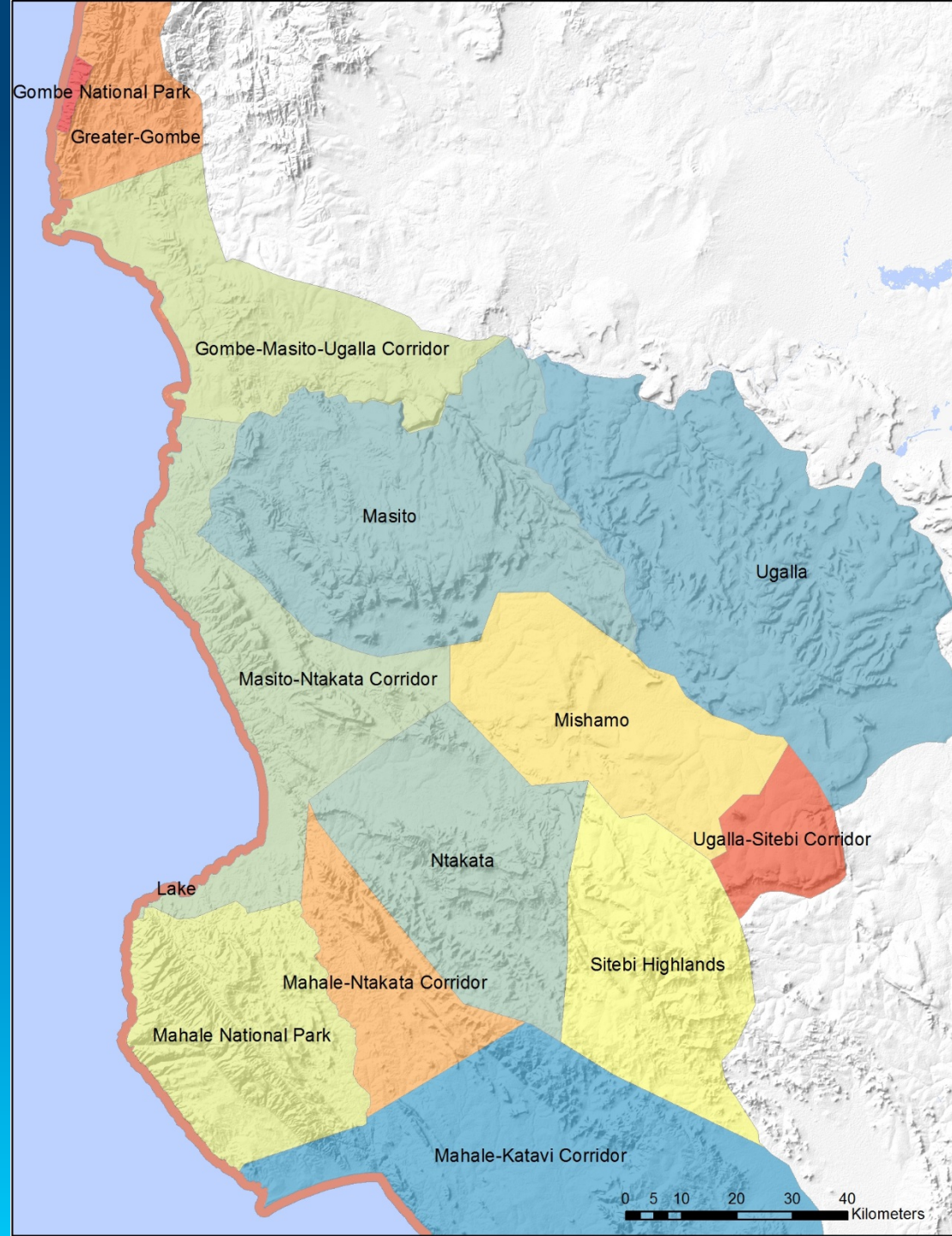
2.6 - 5.0 (Fair)

5.1 - 26.0 (Poor)

0 5 10 20 30 40  
Kilometers







# Chimp habitat health 2014

% of 2000 baseline forest loss

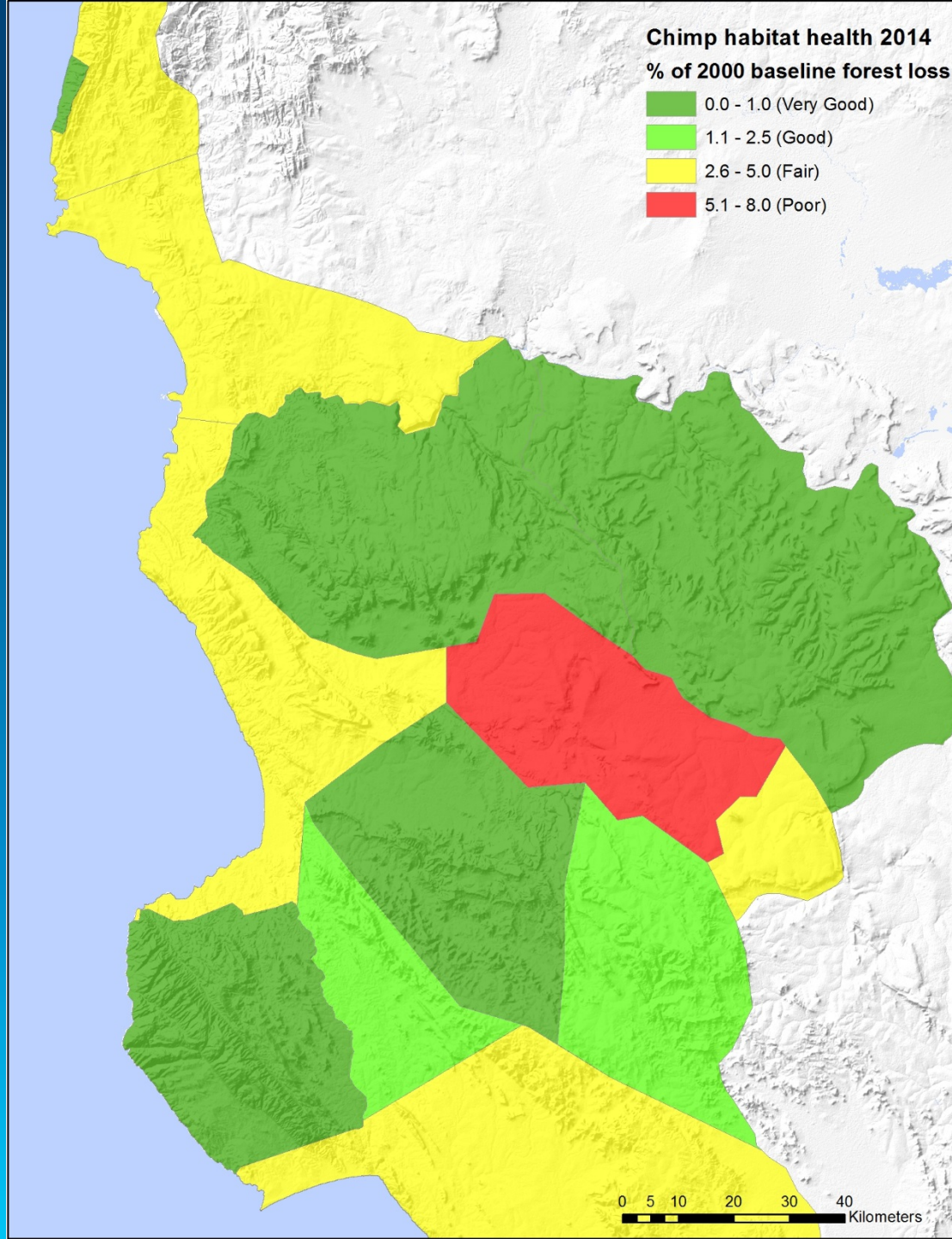
0.0 - 1.0 (Very Good)

1.1 - 2.5 (Good)

2.6 - 5.0 (Fair)

5.1 - 8.0 (Poor)

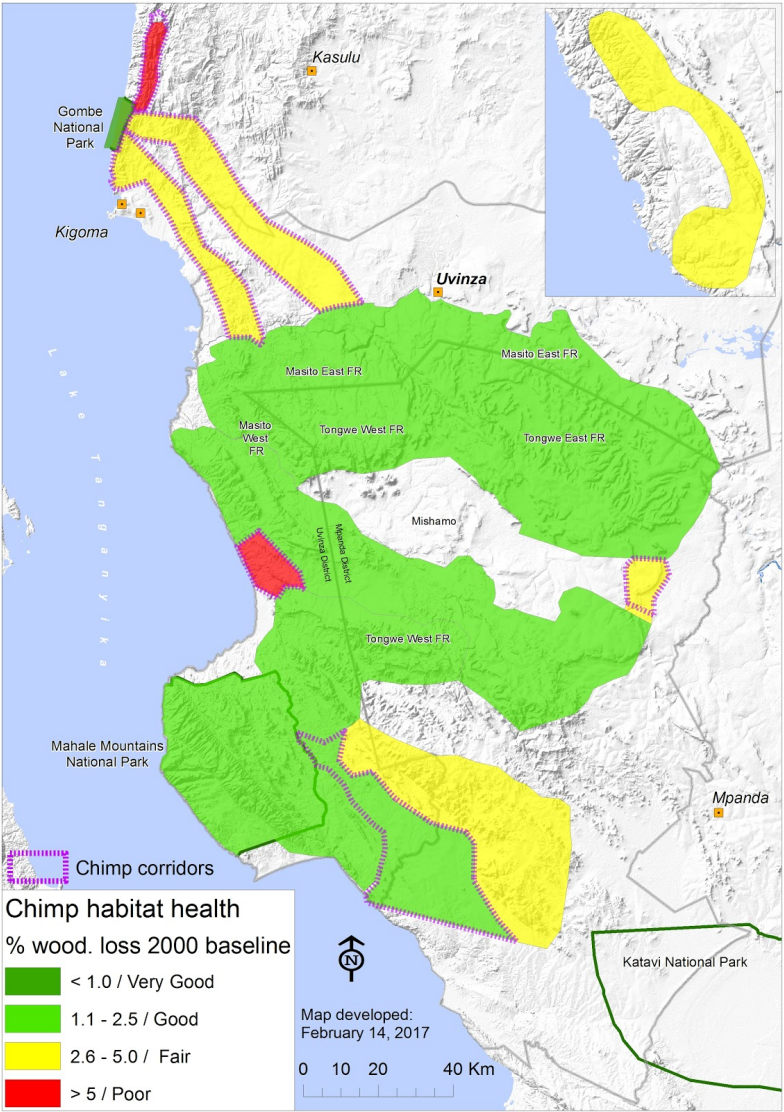
0 5 10 20 30 40  
Kilometers



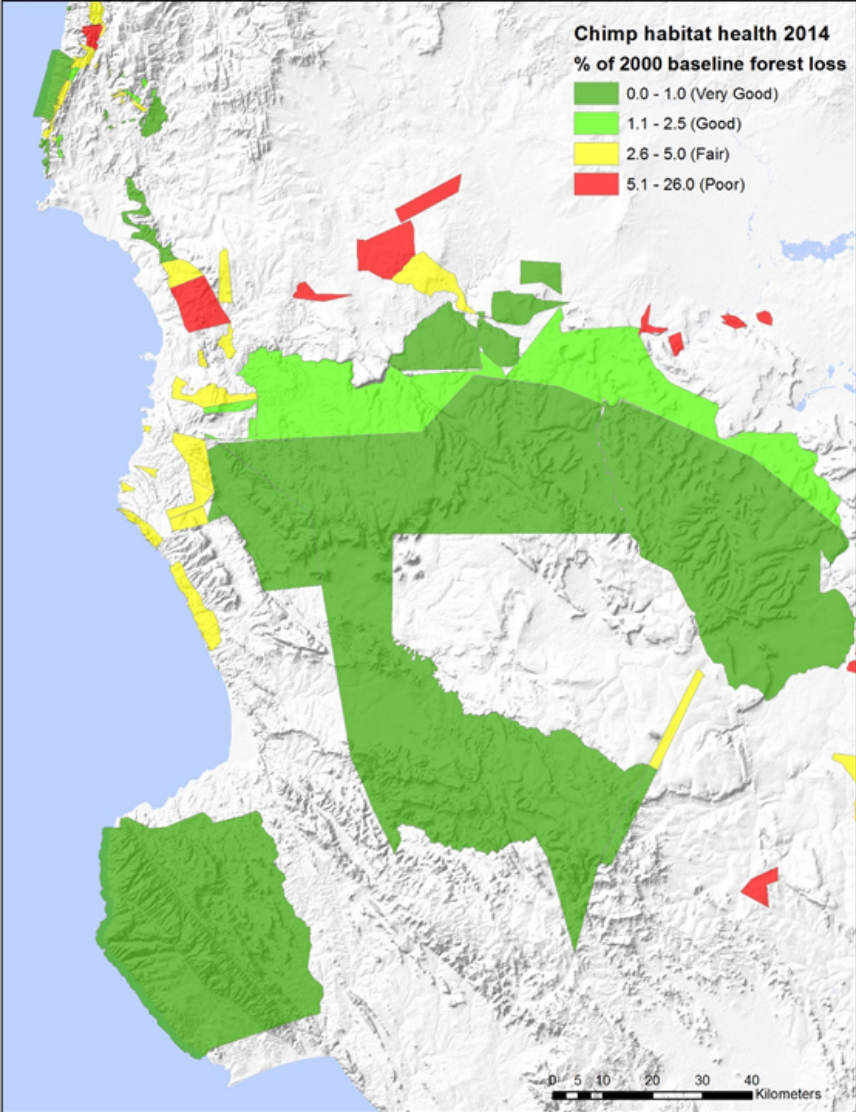


# Management Units for National Chimpanzee Management Plan in Tanzania

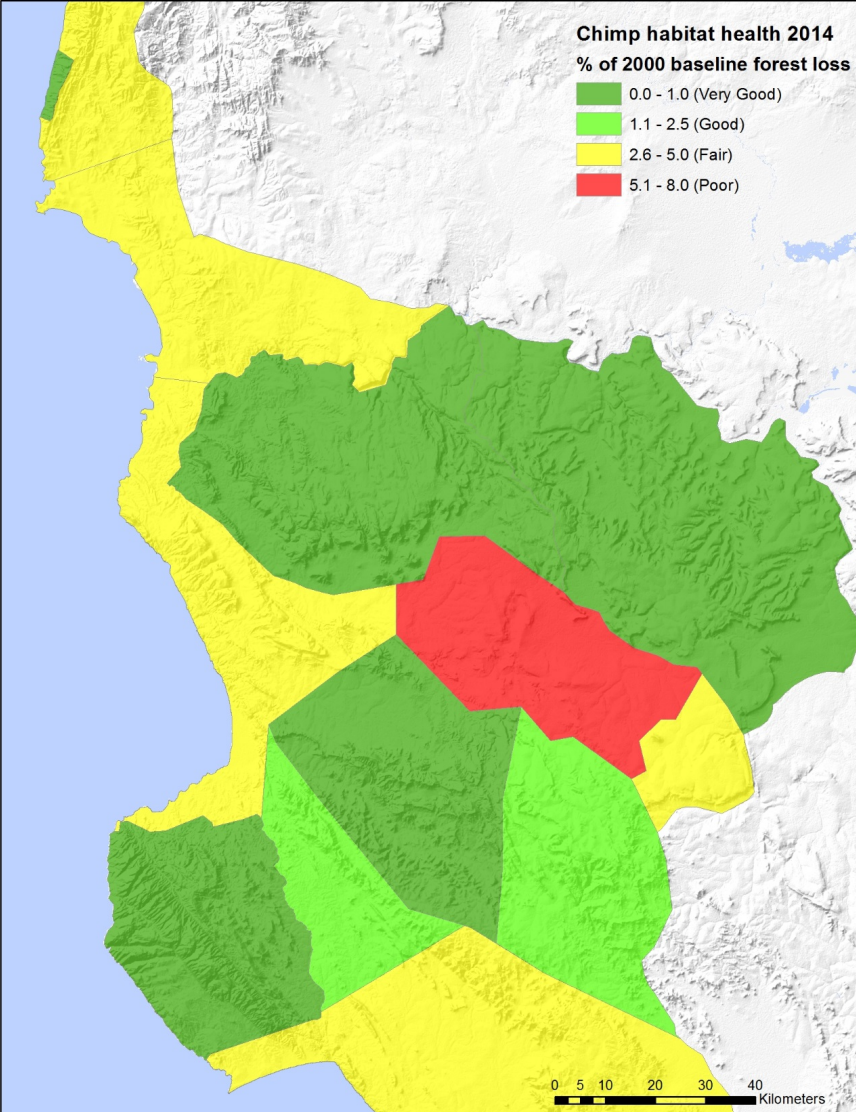
## Chimpanzee Ranges



## Protected Areas

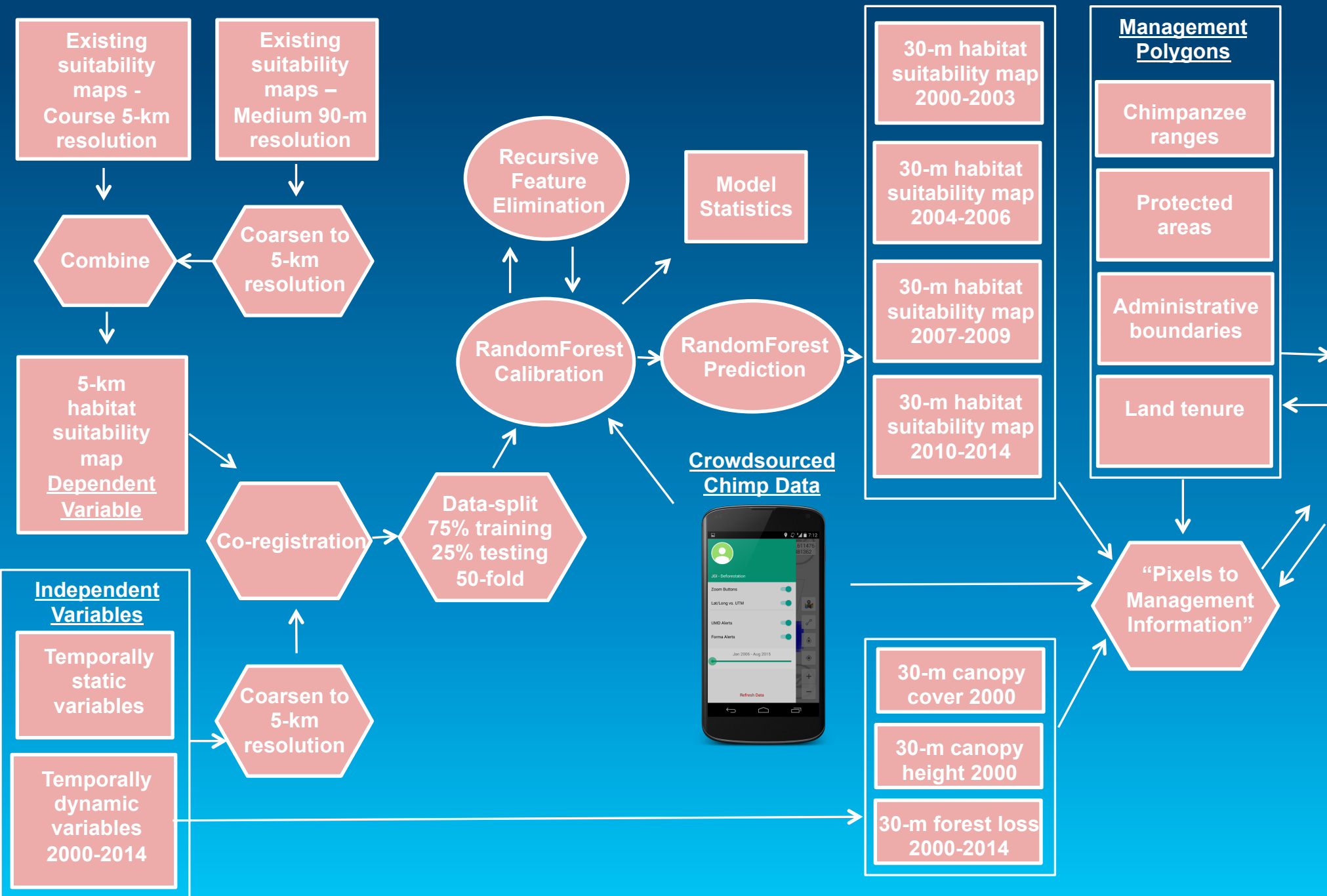


## Combination National scale



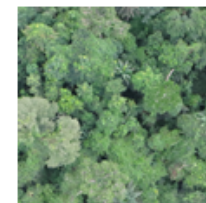
# DSS Workflow

## Decision Makers





# OS Viability Analysis: Markings to Interpret Target Health



**Poor:**  
Restoration  
increasingly difficult;  
May result in  
extirpation

**Fair:**  
Outside acceptable  
range of variation;  
Requires intervention  
to get to good

**Good:**  
Within acceptable  
range of variation;  
Some intervention  
required to maintain

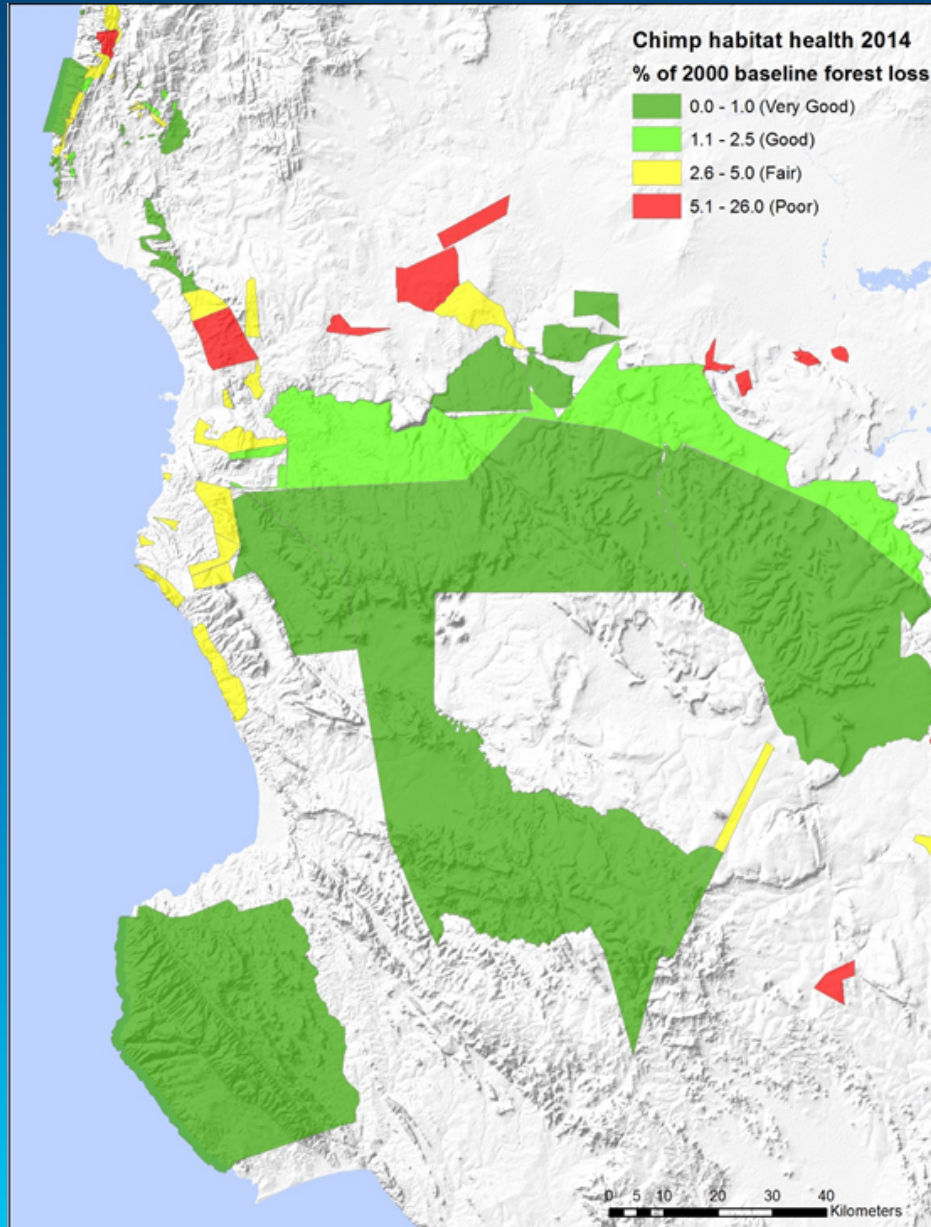
**Very Good:**  
Ecologically desirable  
status; Requires little  
intervention to  
maintain



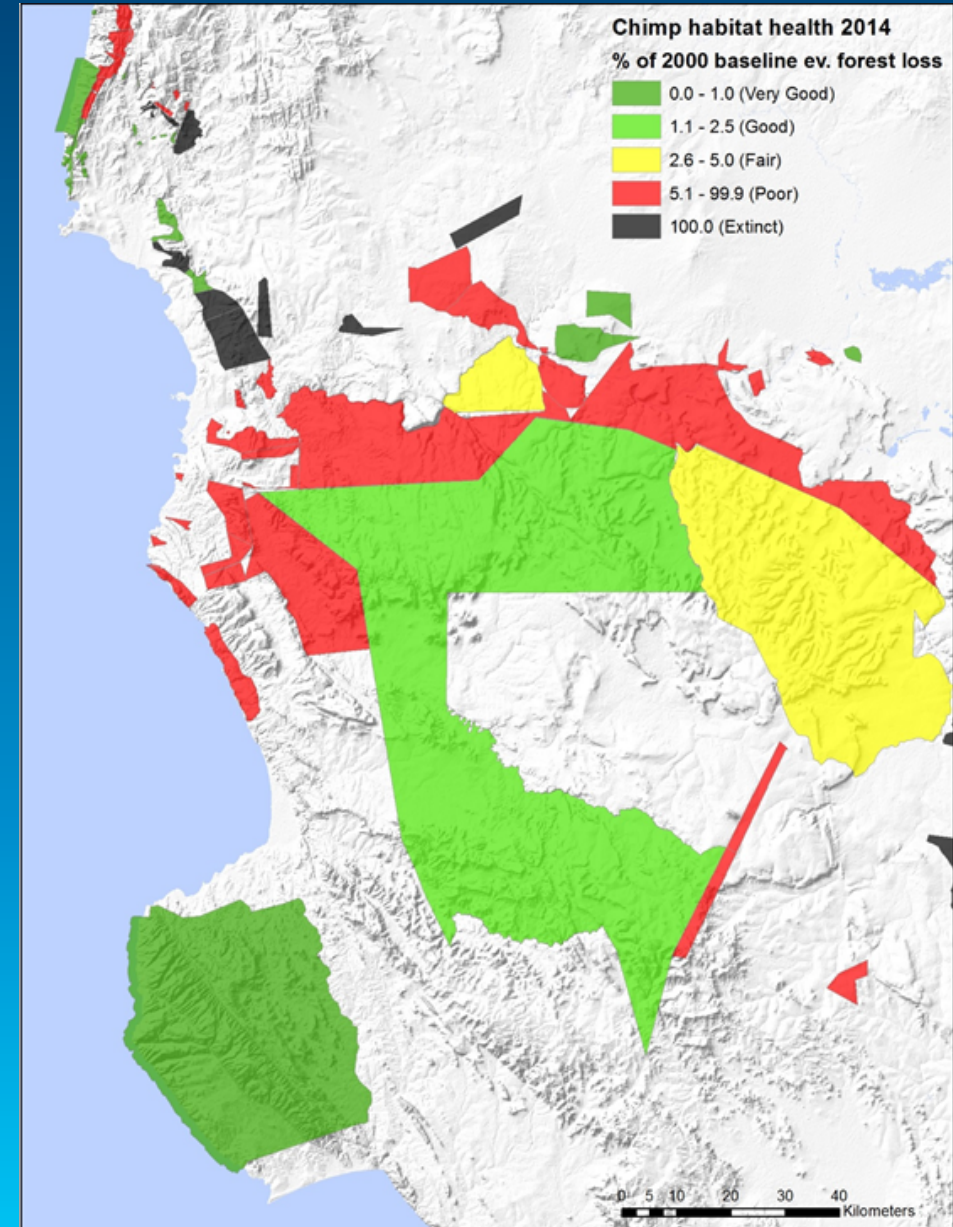
				Indicator Ratings			
Target	Category	KEA	Indicator	Poor	Fair	Good	Very Good
Chimp Habitat in Zambeian Miombo Woodland	Size	Area with tree cover	% of 2000 baseline area loss	> 5 % loss	2.5 - 5.0 % loss	1 - 2.5% loss	< 1% loss
	Condition	Evergreen forest	% of 2000 baseline area loss	> 10% loss	5 - 10% loss	1 - 5% loss	< 1% loss
	Landscape context	Distance to humans	Avg pixel dist to human feature	< 250 m	250 - 500 m	500 - 1000 m	> 1000 m

# Status of Chimpanzee Habitat Health by Protected Area & Suitable Habitat

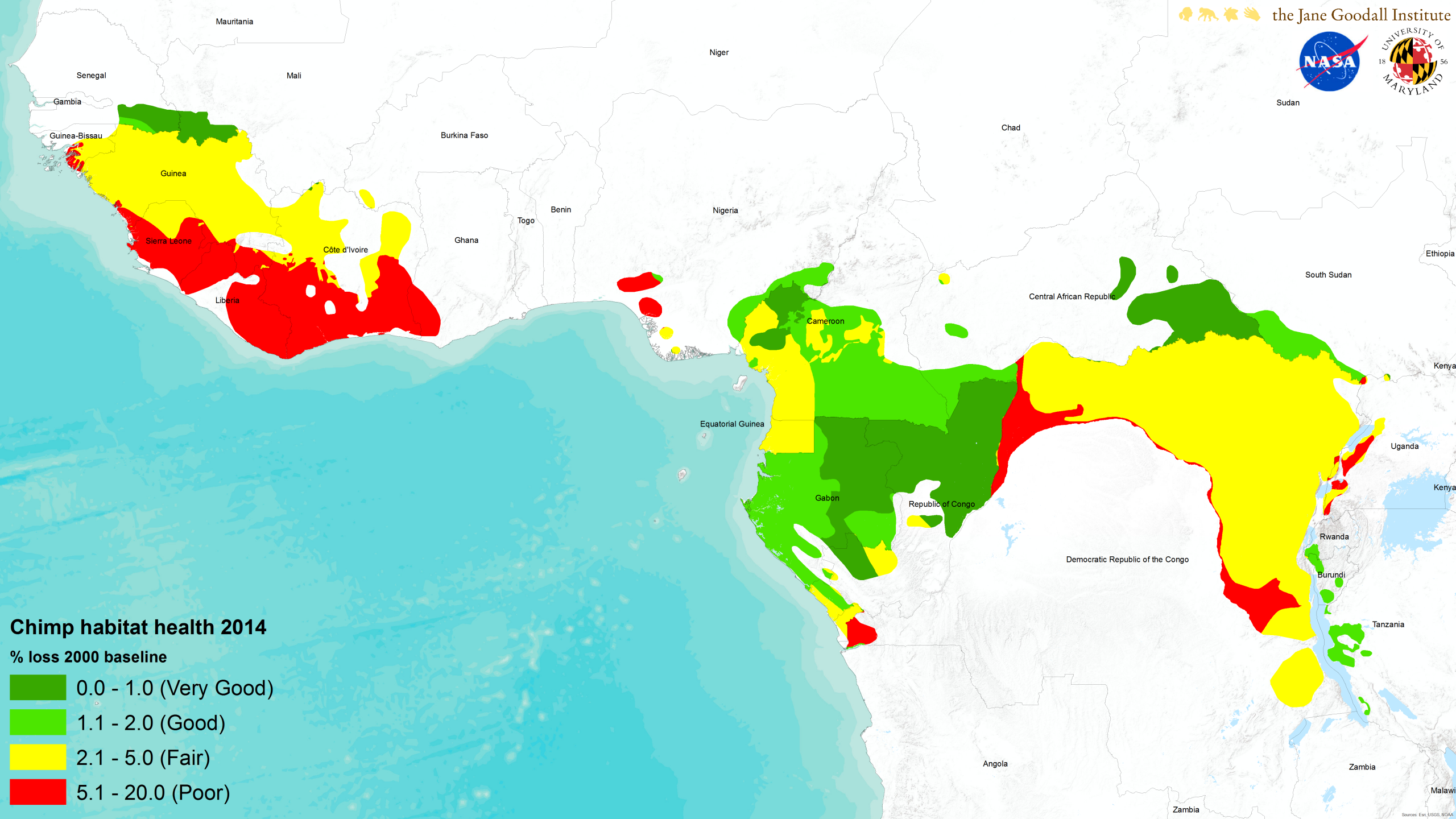
KEA: Size –Forest cover (Woodland & Evergreen Forest)



KEA: Condition – Evergreen Forest





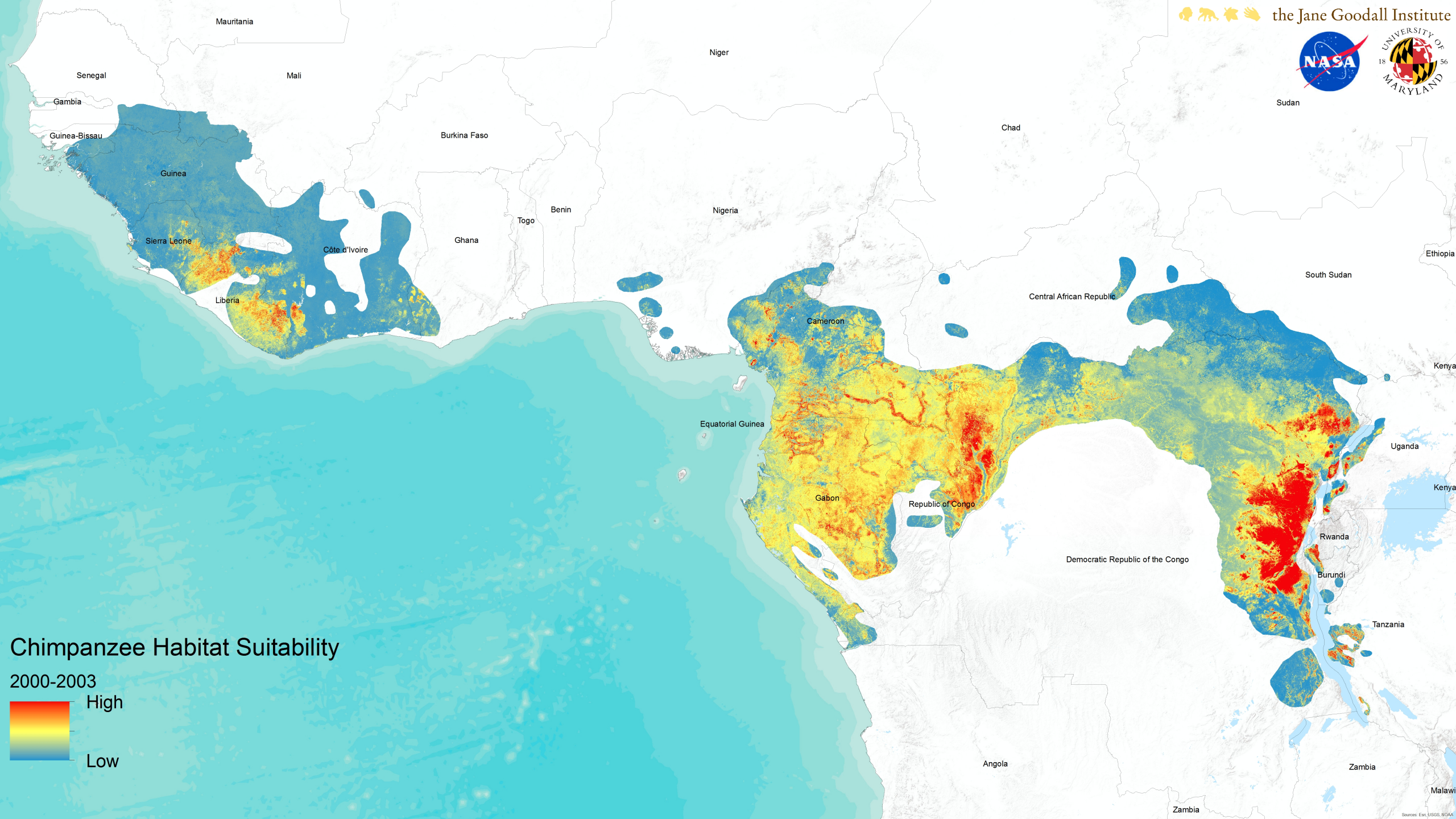


# Chimp habitat health 2014

% loss 2000 baseline

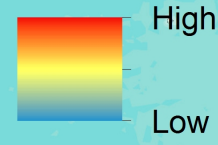
- 0.0 - 1.0 (Very Good)
- 1.1 - 2.0 (Good)
- 2.1 - 5.0 (Fair)
- 5.1 - 20.0 (Poor)





# Chimpanzee Habitat Suitability

2000-2003



High

Low

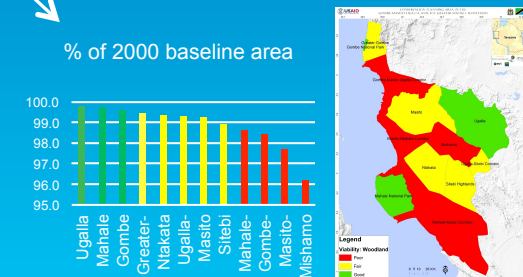


# DSS Workflow

## Decision Makers



## Dashboards, Maps & Stats



## Management Polygons

Chimpanzee ranges

Protected areas

Administrative boundaries

Land tenure

30-m habitat suitability map 2000-2003

30-m habitat suitability map 2004-2006

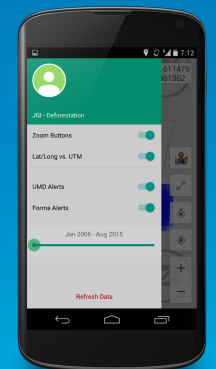
30-m habitat suitability map 2007-2009

30-m habitat suitability map 2010-2014

Model Statistics

RandomForest Prediction

Crowdsourced Chimp Data



Recursive Feature Elimination

RandomForest Calibration

Data-split 75% training 25% testing 50-fold

Coarsen to 5-km resolution

Co-registration

Coarsen to 5-km resolution

Existing suitability maps - Course 5-km resolution

Existing suitability maps - Medium 90-m resolution

Combine

5-km habitat suitability map Dependent Variable

Independent Variables

Temporally static variables

Temporally dynamic variables 2000-2014